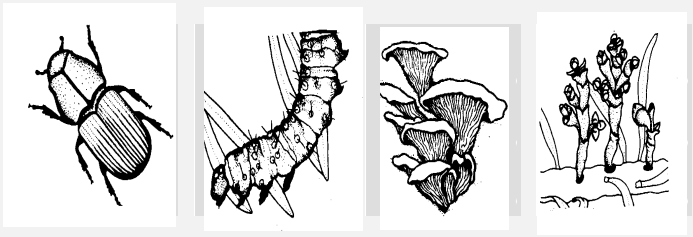
Forest Health Protection



Report 98-4 **October 1998**

DOTHISTROMA NEEDLE BLIGHT OF LIMBER PINE IN MONTANA

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ABSTRACT

Dothistroma septospora appears to be associated with mortality of *Pinus flexilis* in Montana. Nine monitoring transects have been established at several Montana locations. Mortality has been monitored on four transects on the Lewis and Clark National Forest since 1996 and ranged from 12-45%, with 85% of the mortality attributed to *D. septospora*. The remaining five transects were established in 1998, and mortality data are not yet available. However, on the newly established transects, trees were rated for percent crown affected by *D. septospora*; 72% of the trees were rated as having 75% or greater of their crown affected. Monitoring of existing transects for defoliation and mortality associated with *D. septospora* will continue into the future, and additional surveying and monitoring may be undertaken if the current outbreak continues or if new areas of infection are discovered.

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INTRODUCTION

In Montana, limber pine (*Pinus flexilis* James) is found primarily east of the Continental Divide where it commonly dominates forest stands on relatively dry sites in the interface zone between forest and rangeland. Starting in 1995, the Forest Health Protection (FHP) staff (USDA Forest Service) in Missoula began receiving inquiries from Forest Service personnel on the Lewis and Clark National Forest regarding the condition of the limber pine in several locations. The damage reported included trees with reduced terminal growth and poor needle retention and stands with substantial mortality. FHP pathologists and entomologists visited some sites of concern late in the summer of 1995. These investigations failed to provide evidence of a definitive biological cause of the damage. In some locations, there was evidence of defoliation by a needle cast fungus identified as *Lophodermella arcuata* (Darker) (Darker). However, *L. arcuata*, causes defoliation of only 1-year-old needles (Shaw and Leiphart 1960). On the observed trees, 1-year-old needles were present, but 2-year-old and older were absent. White pine blister rust (*Cronartium ribicola* Fisch.) was found in many stands, but at fairly low levels, and no mortality could be attributed to the rust. Examinations for root disease pathogens were negative. Various secondary twig beetles were found in a few trees, and an occasional tree was found that had been killed by the mountain pine beetle (*Dendroctonus ponderosae* Hopkins). None of the pathogens or insects identified in 1995 were found to a great enough degree to be considered a major factor in the limber pine decline. Therefore, the condition of the limber pine problem was attributed to abiotic events such as severe winters, like the one that occurred in eastern Montana in 1989, and several successive drought years, combined with the inherent harshness of limber pine sites.

In 1998, evidence was found that shed new light on a possible biological cause for the damage. During examinations of limber pine stands in May and June, consistent symptom patterns were observed in many locations in Montana (Taylor and Gibson 1998; Taylor and Schwandt 1998). Trees were often observed with red needles, with damage most severe in small trees and in the lower crown of large trees. Close examination revealed that the red discoloration was most pronounced on 2-year-old needles; needles older than 2 years were often absent. Affected needles were green at the base with brown tips or reddish-brown spots or bands. Round, black fruiting bodies were commonly observed in discolored portions of needles. All of these symptoms are typical of a needle disease caused by the fungus *Dothistroma septospora* (Dorog.) Morelet. Surveys were initiated to verify *D. septospora* as the causal agent of the limber pine needle blight, and to determine the extent of the infection in

limber pine in Montana. Monitoring transects were established to study annual defoliation and mortality.

METHODS

In June 1998, needles were collected from limber pines at 22 different locations representing 15 different counties in Montana (Figure 1).

Nine monitoring transects were established at six Montana locations (Figure 1). Four of the transects were established on the Lewis and Clark National Forest in 1996 (Taylor and Campbell 1998). The other five transects were established in 1998, three on private land north of Livingston, and two on Bureau of Land Management land near Wise River. Trees within these nine transects were tagged and will be monitored annually for several years to record defoliation and mortality. A total of 248 trees were tagged on the Lewis & Clark transects, and a total of 217 trees were tagged on the transects near Livingston and Wise River.

RESULTS

D. septospora was positively identified on limber pine needles from 17 of the 22 sample locations (Figure 1). *D. septospora* was also found on whitebark pine (*Pinus albicaulis* Engelm.) at two locations in the southern end of the Crazy Mountains in central Montana. The identity of the fungus was verified by Dr. James Walla, Plant Pathologist at North Dakota State University, Fargo. Symptomatic trees were noted at numerous other locations in Montana, but microscopic examinations of needles from those trees were not done.

Preliminary results from the transects indicated that the disease was quite damaging in some areas. On the Lewis and Clark transects, mortality rates ranged from 12-45% (Figure 2). Eighty-five percent of the mortality appeared related to *D. septospora* defoliation. Other causes of tree mortality included blister rust and suppression. Trees on the newly established transects were rated for amount of crown affected by *D. septospora* defoliation, and 72% were rated as having 75% or greater of their crown affected. Trees on the two transects near Wise River had evidence of severe defoliation by both *D. septospora* and *L. arcuata.* The combination of two foliar pathogens on the same tree could have especially severe effects.

On several of the transects, there was evidence of disease resistance in individual limber pines. While most trees in the surrounding stand were infected, these individuals showed no visible evidence of infection. Resistance to *D. septospora* has been documented in other pines, including Austrian (Peterson 1981), ponderosa (Peterson 1984), and Monterey (Wilcox 1982). Therefore, there is cause to suspect that resistance may occur in limber pine as well.

DISCUSSION

Biology of *Dosthistroma septospora*

Dothistroma septospora (syn. *Dothistroma pini* Hulbary) is the imperfect stage of the ascomycete *Mycosphaerella pini* Rost. in Munk. The *Dothistroma* stage is most commonly seen in the western United States (Evans 1984). *D. septospora* is known to infect numerous *Pinus* species worldwide, and it has been identified on 29 species of pine, including two-, three-, and five-needle pines in the United States (Patton 1997). The fungus has previously been found on ponderosa pine (*Pinus ponderosa* Laws), lodgepole pine (*P. contorta* Dougl.) and western white pine (*P. monticola* Dougl.) in locations in northern Idaho and western Montana (James 1981; Thyr and Shaw 1964). The only previous report of the pathogen in limber pine was from artificial plantings in Kansas, Nebraska, and Ohio (Peterson, 1981).

The disease cycle of *D. septospora* on limber pine in Montana is not specifically known, but is probably similar to that described on other hosts in western North America. Asexual spores, called conidia, are produced in tiny, black fruiting bodies on infected needles (Figure 3). Fruiting bodies develop during the year following infection and usually mature and produce conidia the following spring (Peterson 1967). Conidia are released during wet weather and are dispersed by rain splash throughout the growing season. Infection can potentially occur throughout the spring and summer whenever there is sufficient moisture. Conidia are capable of infecting current-year and 1-year-old needles. Two growing seasons are required for the fungus to complete its life cycle in most parts of North America (Peterson 1982). Although the length of the life cycle in Montana is not known, it is likely 2 years.

Symptoms can occur on current-year, 1-year- and 2-year-old needles. Initial symptoms are faint yellow and tan spots and bands that appear on current-year or 1-year-old needles in the fall of the year of infection. Symptoms become more obvious the following year as the spots and bands turn reddish-brown (Figure 3). The fungus

develops within the necrotic areas, killing the tips of the needles while the bases remain green. As the disease progresses, the base of the needles die and the needles are prematurely shed. Infected needles fall in late spring or early summer. On limber pine, symptom expression was most evident in June on 2-year-old needles. Disease severity is usually greatest in small trees and in the lower crown of larger trees (Peterson 1982). However, in severe disease situations, even large trees can suffer defoliation throughout the entire crown (Figure 4).

Direct mortality of mature trees infected with *Dothistroma* is uncommon, but heavy defoliation may make trees more susceptible to killing by other agents, including other pathogens, insects, or abiotic events such as winter damage or drought (Etheridge 1967). Since needle diseases are cyclical in nature and closely related to climatic conditions (Funk 1985) it is probable that severe damage is the result of several successive years of favorable weather.

Disease effects

There are no reports concerning the effects of *D. septospora* on limber pine growth and mortality, but information is available about effects on other hosts. The fungus may be quite damaging to ponderosa, lodgepole, Austrian (*P. nigra* Arnold), and Monterey (*P. radiata* D. Don) pines - especially in off-site plantings. *D. septospora* has caused complete failure of most ponderosa pine plantings in the United States east of the Great Plains (Peterson 1982). In Kansas, Nebraska, and Oklahoma, Austrian and ponderosa pine in Christmas tree, shelterbelt, and landscape plantings often suffer such extensive damage that fungicidal control is often warranted, and these tree species are no longer planted in some areas. (Peterson 1981). Studies on Monterey pine planted in Kenya show that reductions in diameter growth occur after defoliation exceeds 25% (Christensen and Gibson 1968). When defoliation exceeds 75%, growth is about one-tenth that of a healthy tree. In another study (Shaw and Toes 1977), *D. septospora* infection was associated with 17-73% annual growth loss in plantations of 8- to 10-year-old Monterey pine in New Zealand. Monterey pine in California was found to be highly susceptible (Cobb and Miller 1968), but infection was severe only in plantations located north of the natural range of the pine.

Severe damage by *D. septospora* is uncommon in natural stands (Peterson 1981). However, the severe damage occurring in natural stands of limber pine may be due to the ecology of the sites where limber pine grows in Montana. Typically, limber pines stands are found on dry, rocky sites with gravelly soils of calcareous origin and poor duff accumulation (Pfister et al. 1983). Site productivity is generally low to very low. Areas where limber pine grows generally have a continental climate, typified by little precipitation, mostly coming as winter snow and early summer rain (Steele 1990). Winter conditions can be very cold and often include rapid temperature fluctuations and high wind. Given the inherent harshness of the limber pine growing sites, with droughty summer conditions and extreme winter weather, severe defoliation from *D. septospora* may be an additional stressor sufficient to cause widespread mortality. Mortality associated with *D. septospora* is worse in stands along the rangeland interface zone (personal observation). This observation gives rise to an additional theory that perhaps, largely due to fire suppression, limber pine has encroached further into the range interface over the past century, and perhaps some of this encroachment could be considered somewhat "off-site."

With the introduction of white pine blister rust, and the subsequent spread of the disease into much of the range of 5-needle pines in Montana, most limber pine mortality has been assumed to be rust related. However, *D. septospora* may also be responsible for limber pine mortality in some Montana locations. The presence of another serious disease agent in limber pine, a species already facing the threat of blister rust, may have serious implications. Some level of genetic resistance to blister rust may occur in limber pine individuals. If rust resistant trees are not also resistant to *D. septospora*, this potential source of

genetic resistance may be lost during a severe needle blight outbreak. During severe needle blight outbreaks, a substantial number of trees may be killed, and the survival of new seedlings will be limited by the rust and needle blight.

ACKNOWLEDGEMENTS

We gratefully acknowledge Dr. James A. Walla, North Dakota State University, for his assistance in confirming the identity of *D. septospora.* We also thank Cynthia Kingston for allowing the establishment of transects on the C2D property.

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Figure 2. Limber pine mortality associated with *Dothistroma septospora*.

Figure 4. Severe defoliation of mature limber pine by *Dothistroma septospora.*

Figure 3. Typical symptoms on needles infected with *Dothistroma septospora*: brown bands, needle tips brown, needle bases green. Note black fruiting bodies in brown needle tissue.